

Nanoparticle-Polymer Composite Membranes

Alan A. Jones, Clark University, DMR- 0209614

Membranes composed of polymers are used in many applications including energy efficient separations, fuel cells and batteries. Recently the addition of silica nanoparticles to the polymer (Figure 1) has provided a new approach to increase the speed at which small molecules can cross the membrane by up to an order of magnitude¹⁻². At Clark, nuclear magnetic resonance (NMR) spectroscopy is used to follow the motion of the small molecules in the polymer/nanoparticle composite. The goal is to understand both the dynamic and structural character of these materials which control application related properties. The 2D NMR experiment in Figure 2 shows the small molecule touches the nanoparticles as it crosses the membrane elucidating the nanoparticle role.

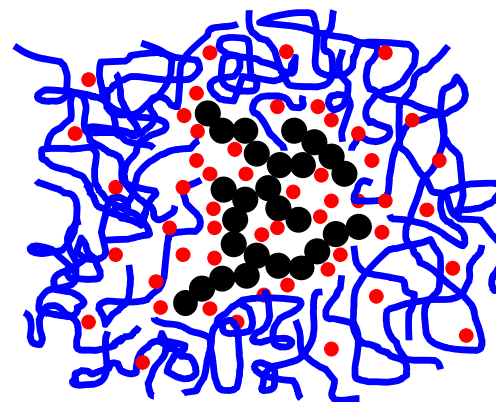


Fig 1. Pictorial representation of nanocomposite with polymers (blue), nanoparticles (black) and small molecules (red).

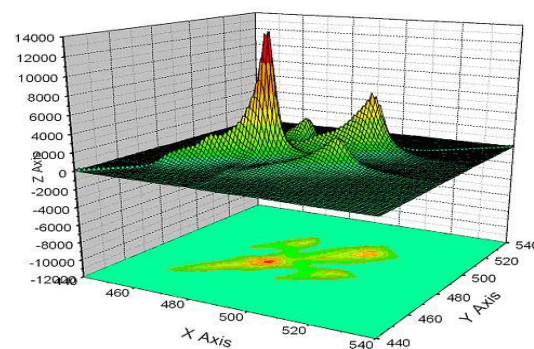


Fig 2. This two dimensional NMR experiment shows two large peaks along the diagonal from protons on the nanoparticle and on the small molecule plus off diagonal peaks, indicating contact between them.

Education: The polymer NMR group at Clark consists of postdoctoral fellows Marcus Giotto and Guoxing Lin, graduate students Haihui Cao, Jinghui Zhang, Ernest Krygier and JunYan Zhong plus undergraduates Jessica Mendes, Elysia Alvarez and Darryl Aucoin. The polymer/nanoparticle NMR experiments have been the primary work of JunYan with Darryl extending the work over the summer in collaboration with JunYan and with the assistance of Professor Emeritus Wen-Yang Wen. The nanocomposite membrane experiments are also a collaboration with the group of Professor Benny Freeman at the University of Texas, Austin.

References:

1. Merkel, T. C., Freeman, B. D., Spontak, J. R., He, Z., Pinnau, I., Meakin, P., Hill, A. J. *Science*, **2002**, 296, 519-522.
2. Zhong, J., Wen, W.-Y., Jones, A. A. *Macromolecules*, **2003**, 36, 6430.



This picture of the polymer NMR group was taken in the fall of 2003 during a group meeting. The recent results of each researcher are discussed and future experiments are planned. At this meeting the students brought a birthday cake for Professor Jones' 59th birthday.